Directional or Non-Directional Earth-Fault Relay

REJ 527

Product Guide

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1MRS751132-MBG

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Features

- Directional or non-directional low-set earth-fault current stage with definite-time or inverse definite minimum time (IDMT) characteristic
- Directional or non-directional high-set earth-fault current stage with definite-time characteristic
- Deblocking zero-sequence voltage stage with definite-time characteristic
- The two earth-fault current stages can be configured to operate alternatively as two voltage stages: three-stage voltage monitoring operation possible
- Intermittent earth-fault protection
- Circuit-breaker failure protection (CBFP)
- Disturbance recorder
  - recording time up to 19 seconds
  - triggering by a start or a trip signal from any protection stage and/or by a binary input signal
  - records two analogue channels and seven digital channels
  - adjustable sampling rate
- Non-volatile memory for
  - up to 60 event codes
  - setting values
  - disturbance recorder data
  - recorded data of the five last events with time stamp
  - number of starts for each stage
  - alarm indication messages and LEDs showing the status at the moment of power failure
- Galvanically isolated binary input with a wide input voltage range
- All settings can be modified with a personal computer
- HMI with an alphanumeric LCD and manoeuvring buttons
- IEC 60870-5-103 and SPA bus communication protocols
- Two normally open power output contacts
- Two change-over signal output contacts
- Output contact functions freely configurable for desired operation
- Optical PC-connector for two-way data communication (front)
- RS-485 connector (rear) for system communication
- Continuous self-supervision of electronics and software. At an internal relay fault (IRF), all protection stages and outputs are blocked.
- User-selectable rated frequency 50/60 Hz
- User-selectable password protection for the HMI
- Display of primary current and voltage values as well as phase angle values
- Multi-language support

Application

The directional or non-directional earth-fault relay REJ 527 is a secondary relay which is connected to the voltage and current transformers of the object to be protected. The earth-fault current and the zero-sequence voltage unit continuously measure the zero-sequence voltage, earth-fault current and phase angle of the object. On detection of a fault, the relay will start, trip the circuit breaker, provide alarms, record fault data, etc., in accordance with the application and the configured relay functions.

The voltage unit includes low-set stage $U_0b>$ and the earth-fault current unit low-set stage $I_0>$ and high-set stage $I_0>>$. The earth-fault stages can be replaced by two additional voltage stages, low-set stage $U_0>$ and high-set stage $U_0>>$.

The protection functions are independent of each other and have their own setting groups and data recordings. The voltage and current functions use conventional transformer measurement.

An output contact matrix allows start or trip signals from the protection stages to be routed to the desired output contact.

Design

The relay includes a high-set and low-set earth-fault current unit, a zero-sequence voltage unit and a circuit-breaker failure protection unit. Further, the relay includes an HMI module, a self-supervision system and a disturbance recorder.

Directional or non-directional earth-fault current unit

The high-set and the low-set stage the directional earth-fault current unit can be configured to be either directional or non-directional. The directional earth-fault stages can be given either a basic angle or a sin(φ) or a cos(φ) characteristic.

The start and the tripping of the directional earth-fault stages with the basic angle characteristic are based on measuring the earth-fault current, I_0, the zero-sequence voltage, U_0, and the phase angle, φ, between the voltage and the current. An earth-fault stage will start when the following three criteria are fulfilled at the same time:

- The earth-fault current, I_0, exceeds the set start value of the low- or high-set earth-fault stage.
- The zero-sequence voltage, U_0, exceeds the set start value of $U_{0b}>$, which is the same for both stages in the deblocking mode.
- The phase angle, φ, between the voltage and current falls within the operation sector $\varphi_b \pm \Delta\varphi$.

The basic angle of the network is -90° for isolated neutral networks and 0° for resonant earthed networks, earthed with an arc suppression coil (Petersen coil) with or without a parallel resistor. The operation sector is selectable and can be either $\Delta\varphi = \pm 80°$ or ±88°. Both operation sectors can be extended.

When an earth-fault stage starts, a start signal will be generated and a start indication shown on the HMI. If the above mentioned criteria remain fulfilled until the set operate time elapses, the stage will deliver a trip signal and a trip indication will be shown on the HMI. The trip indication will remain active although the protection stage is reset. The direction of the fault spot is determined by means of the angle between the voltage and the current. Basic angle φ_b can be set between -90° and 0°. When basic angle φ_b is 0-°, the negative quadrant of the operation sector can be extended with φ_a. Extended operation sector φ_a can be set between 0 and 90°.

The start and the tripping of the directional earth-fault stages with the sin(φ) or the cos(φ) characteristic are based on measuring the earth-fault current, I_0, the zero-sequence voltage, U_0, and the phase angle, φ, between the voltage and the current. The sinus or cosinus value of the phase angle is calculated and multiplied by the earth-fault current to get the directional earth-fault current, I_φ. An earth-fault stage will start when the following three criteria are fulfilled at the same time:

- The directional earth-fault current, Iφ, exceeds the set start value of the low- or high-set earth-fault stage.
- The zero-sequence voltage, U_0, exceeds the set start value of $U_{0b}>$, which is the same for both stages in the deblocking mode.
- The phase angle, φ, between the voltage and the current falls within the operation sector, corrected with φ_c.

When an earth-fault stage starts, a start signal will be generated and a start indication shown on the HMI. If the above mentioned criteria remain fulfilled until the set operate time elapses, the stage will deliver a trip signal and a trip indication will be shown on the HMI. The trip indication will remain active although the protection stage is reset. The direction of the fault spot is determined by means of the angle between the voltage and the current. Directional earth-fault characteristic sin(φ) corresponds to the earth-fault protection with the basic angle -90° and cos(φ) to the earth-fault protection with the basic angle 0°.

The operation directions, forward or reverse, of the directional earth-fault stages can be selected independently of each other. The directional stages may also be separately configured to be non-directional.

The low-set stage $I_0>$ can also be used for protection against intermittent earth-faults, which may occur in insulated cables used in compensated networks.

When the earth-fault current exceeds the set start value of low-set stage $I_0>$, the earth-fault unit will start to deliver a start signal after a ~70 ms' start time. When the set operate time at definite-time characteristic or the calculated operate time at inverse definite minimum time (IDTM) characteristic elapses, the earth-fault unit will deliver a trip signal.

When the earth-fault current exceeds the set start value of high-set stage $I_0>>$, the earth-fault unit will start to deliver a start signal after a ~60 ms' start time. When the set operate time elapses, the earth-fault unit will deliver a trip signal.

It is possible to block the start and the tripping of an earth-fault stage by applying an external binary input signal to the relay.

The low-set stage of the earth-fault unit can be given either a definite-time or an inverse IDMT characteristic. At IDMT characteristic, six time/current curve groups are available, of which four comply with the IEC 60255 standard: the normal inverse, very inverse, extremely inverse and long time inverse. The two additional IDMT curve groups, referred to as RI and RD, are special curve groups according to ABB praxis.

The inverse-time function of stage I_0> can be set to be inhibited when stage I_0>> starts. In this case the operate time will be determined by stage I_0>>.

The high-set stage can be set out of operation. This state will be indicated by dashes on the LCD and by “999” when the set start value is read via serial communication.

The set start value of stage I_0>> can be automatically doubled in a start situation, e.g. when the object to be protected is connected to a distribution network. Thus a set start value below the connection inrush current level may be selected for stage I_0>>. A start situation is defined as a situation where the earth-fault current rises from a value below 12% x I_0> to a value above 150% x I_0> in less than 60 ms. The start situation ends when the current falls below 125% x I_0>.

Zero-sequence voltage unit

When the zero-sequence voltage exceeds the set start value of low-set stage U_{0b}>, the voltage unit will start to deliver a start signal after a ~70 ms’ start time. When the set operate time at definite-time characteristic elapses, the voltage unit will deliver a trip signal.

The two current stages, I_0> and I_0>>, can be replaced by two additional voltage stages, low-set stage U_0> and high-set stage U_0>>, to create a three-stage zero-sequence voltage module. All three voltage stages measure the same voltage but can have separate settings both regarding sensitivity and operate time. The signalling and trip relays can also be selected separately for all three stages.

When the zero-sequence voltage exceeds the set start value of low-set stage U_0>, the voltage unit will start to deliver a start signal after a ~70 ms’ start time. When the set operate time at definite-time characteristic elapses, the voltage unit will deliver a trip signal.

When the zero-sequence voltage exceeds the set start value of high-set stage U_0>>, the voltage unit will start to deliver a start signal after a ~60 ms’ start time. When the set operate time elapses, the voltage unit will deliver a trip signal.

It is possible to block the start and the tripping of a voltage stage by applying an external binary input signal to the relay.

High-set stage U_0>> can be set out of operation. This state will be indicated by dashes on the LCD and by “999”when the set start value is read via serial communication.

Circuit breaker failure protection (CBFP) unit

The CBFP unit will generate a trip signal via power output 2 (PO2) if the fault has not been cleared on expiration of the set operate time 0.10 s...1.00 s.

Normally, the CBFP unit controls the upstream circuit breaker. It can also be used for tripping via redundant trip circuits of the same circuit breaker. The CBFP unit is activated with a software switch.

Disturbance recorder

The REJ 527 includes an internal disturbance recorder which records the momentary measured values, or the RMS curves of the measured signals, and seven digital signals: the external binary input signal and the states of the internal protection stages. The disturbance recorder can be set to be triggered by a start or a trip signal from any protection stage and/or by an external binary input signal, and either on the falling or rising triggering edge. The ratio of the pre- and post-triggering of the recording can be set.

The recording length varies according to the selected sampling frequency. The RMS curve is recorded by selecting the sampling frequency to be the same as the nominal frequency of the relay. See the table below for details:

Nominal frequency Hz	Sampling frequency Hz	Recording length s
50	800	1.20
50	400	2.40
50	50	19.20

Nominal frequency Hz	Sampling frequency Hz	Recording length s
60	960	1.00
60	480	2.00
60	60	16.00

HMI module

The HMI of the REJ 527 is equipped with six push-buttons and an alphanumeric 2 x 16 characters' LCD. The push-buttons are used for navigating in the menu structure and for adjusting set values.

An HMI password can be set to protect all user-changeable values from being changed by an unauthorised person.

The REJ 527 offers you multi-language support. The following languages are available for the HMI menu: English, German, French, Spanish, Italian, Swedish and Finnish.

Self-supervision (IRF)

The REJ 527 is provided with an extensive self-supervision system which continuously supervises the software and the electronics of the relay. It manages run-time fault situations and informs the user about an existing fault via a LED on the HMI and a text message on the LCD.

Communication capabilities

The REJ 527 can be connected to a substation automation or monitoring system using either the SPA bus communication protocol or the IEC 60870-5-103 remote communication protocol. Both protocols are supported in the same device.

The SPA bus communication protocol is an asynchronous serial communication protocol (1 start bit, 7 data bits + even parity, and 1 stop bit) with a selectable data transfer rate (default 9.6 kbps). It is a master/slave protocol supporting one master device and several slave devices. The SPA bus protocol can be used to transfer data, e.g. measured currents, registered values, events, and relay settings, between the master and the slave device.

The REJ 527 supports the IEC 60870-5-103 remote communication protocol in the unbalanced transmission mode with a data transfer rate of 9.6 kbps. The IEC 60870-5-103 protocol is used to transfer mesurand and status data from the slave to the master. Disturbance recorder data, however, cannot be transferred using this protocol.

The REJ 527 is provided with two serial communication ports, one on the rear panel and the other on the front panel.

The REJ 527 is interfaced with a fibre-optic bus by means of the bus connection module RER 103 via the D9S-type RS-485 connector on the rear panel of the device. The RER 103 enables the use of either the SPA bus or the IEC 60870-5-103 communication protocol. The use of the IEC 60870-5-103 protocol normally requires the fibre-optic star coupler RER 125.

The optical PC-connector on the front panel is used to connect the relay to the CAP 501/505 setting and configuration tools. The front interface uses the SPA bus protocol. The optical PC-connector galvanically isolates the PC from the relay. Since this connector is standardized for ABB relay products, only one connecting cable (ABB art. No 1MKC-950001-1) will be required.

The REJ 527 can also be connected to the Lon bus using a LON-SPA Gateway.

Auxiliary voltage supply

The REJ 527 requires a secured auxiliary voltage supply to operate. The internal power supply of the relay forms the voltages required by the relay electronics. The power supply is a galvanically isolated (flyback-type) DC/DC converter. When the auxiliary voltage is connected, the READY indicator LED on the front panel will be on.

The primary side of the power supply is protected with a fuse located on the PCB of the relay. The fuse size is 3.15 A (slow).

Technical data

Table 1: Energizing inputs

Rated frequency	50/60 Hz ±5 Hz		
Current input			
Rated current, I_n	0.2 A	1 A	5 A
Thermal withstand capability - continuously - for 1 s	 1.5 A 20 A	 4 A 100 A	 20 A 500 A
Dynamic current withstand - half-wave value	 50 A	 250 A	 1250 A
Input impedance	< 750 mΩ	< 100 mΩ	< 20 mΩ
Voltage input			
Rated voltage, U_n	100/110/115/120 V		
Thermal withstand capability - continuously - for 10 s	 2 x U_n 3 x U_n		
Input impedance	> 4.7 MΩ		

Table 2: Measuring range

Measured residual voltage (U_0) as a percentage of the rated voltage of the energizing input	0...400% x U_n
Measured earth-fault current (I_0) as a percentage of the rated current of the energizing input	0...800% x I_n

Table 3: Binary input

Operating range	18…265 V dc
Rated voltage	U_r = 24/48/60/110/220 V dc
Current drain	~ 2…25 mA
Power consumption	< 0.8 W

Table 4: Power outputs (PO1 and PO2)

Rated voltage	250 V ac/dc
Continuous carry	5 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control circuit time-constant L/R < 40 ms, at 48/110/220 V dc	5 A/3 A/1 A
Minimum contact load	100 mA at 24 V ac/dc

Table 5: Signal outputs (SO1, SO2) and self-supervision (IRF) output

Rated voltage	250 V ac/dc
Continuous carry	5 A
Make and carry for 3.0 s	8 A
Make and carry for 0.5 s	10 A
Breaking capacity when the control circuit time-constant L/R < 40 ms, at 48/110/220 V dc	1 A/0.25 A/0.15 A
Minimum contact load	100 mA at 24 V ac/dc

Table 6: Data communication

Rear interface, connector X2.2	RS-485 connection for the fibre-optic interface module RER 103 SPA bus or IEC 60870-5-103 protocol 4.8 or 9.6 kbps
Front interface	Optical RS-232 connection for opto-cable 1MKC 950001-1 SPA bus protocol 4.8 or 9.6 kbps

Table 7: Auxiliary voltage

U_{aux} rated	Ur =110/120/220/240 V ac Ur =48/60/110/125/220 V dc
U_{aux} variation	80…265 V ac 38…265 V dc
Relay power start-up time, typical	300 ms
Burden of auxiliary supply under quiescent/operating condition	~ 4 W/~ 10 W
Ripple in the dc auxiliary voltage	Max 12% of the dc value
Interruption time in the auxiliary dc voltage without resetting the relay	< 30 ms at 48 V dc < 100 ms at 110 V dc < 500 ms at 220 V dc

Table 8: Enclosure class

Front side	IP 54 (flush-mounted)
Rear side, connection terminals	IP20
Note! A rear protective cover (accessory part) can be used to protect and shield the rear of the case.	

Table 9: Dimensions

Width	Frame 111.4 mm, box 94 mm
Height	Frame 265.9 mm (6U), box 249.8 mm
Depth	235 mm (245.1 mm with a protective rear cover, available as an option)
Enclosure size	1/4 (x 19”)
Weight of the relay	~3.0 kg

Table 10: Environmental tests

Specified service temperature range	-10...+55 °C
Storage temperature tests	-40...+70 °C according to the IEC 60068-2-48
Dry heat test	According to the IEC 60068-2-2
Dry cold test	According to the IEC 60068-2-1
Damp heat test, cyclic	According to the IEC 60068-2-30

Table 11: Standard tests

Insulation tests	
Dielectric tests	According to the IEC 60255-5
Test voltage	2 kV, 50 Hz, 1 min
Impulse voltage test	According to the IEC 60255-5
Test voltage	5 kV, unipolar impulses, waveform 1.2/50 μs, source energy 0.5 J
Insulation resistance measurements	According to the IEC 60255-5
Isolation resistance	> 100 MΩ, 500 V dc
Mechanical tests	
Vibration tests (sinusoidal)	According to the IEC 60255-21-1, class I
Shock and bump test	According to the IEC 60255-21-2, class I
Seismic test	According to the IEC 60255-21-3, class 2

Table 12: Electromagnetic compatibility tests

EMC immunity test level requirements consider the demands in the generic standard EN 50082-2	
1 MHz burst disturbance test, class III	According to the IEC 60255-22-1
Common mode	2.5 kV
Differential mode	1.0 kV
Electrostatic discharge test, class III	According to the IEC 61000-4-2 and IEC 60255-22-2
For contact discharge	6 kV
For air discharge	8 kV

Table 12: Electromagnetic compatibility tests

Radio frequency interference tests	
Conducted, common mode	According to the IEC 61000-4-6 and IEC 60255-22-6 (2000) 10 V (rms), f = 150 kHz…80 MHz
Radiated, amplitude-modulated	According to the IEC 61000-4-3 and IEC 60255-22-3 (2000) 10 V/m (rms), f = 80…1000 MHz
Radiated, pulse-modulated	According to the ENV 50204 and IEC 60255-22-3 (2000) 10 V/m, f = 900 MHz
Radiated, test with a portable transmitter	According to the IEC 60255-22-3, method C; f =77.2 MHz, P=6 W; f =172.25 MHz, P=5W
Fast transient disturbance tests	According to the IEC 60255-22-4 and IEC 61000-4-4
Other terminals	4 kV
Binary input	2 kV
Surge immunity test	According to the IEC 61000-4-5
Power supply	4 kV, line to earth
	2 kV, line to line
I/O ports	2 kV, line to earth
	1 kV, line to line
Power frequency (50 Hz) magnetic field IEC 61000-4-8	100 A/m
Voltage dips and short interruptions	According to the IEC 61000-4-11
	30%/10 ms
	60%/100 ms
	>95%/5000 ms
Electromagnetic emission tests	According to the EN 55011 and EN 50081-2
Conducted, RF-emission (Mains terminal)	EN 55011, class A, IEC 60255-25
Radiated RF-emission	EN 55011, class A, IEC 60255-25
CE approval	Complies with the EMC directive 89/336/EEC and the LV directive 73/23/EEC

Connection diagram

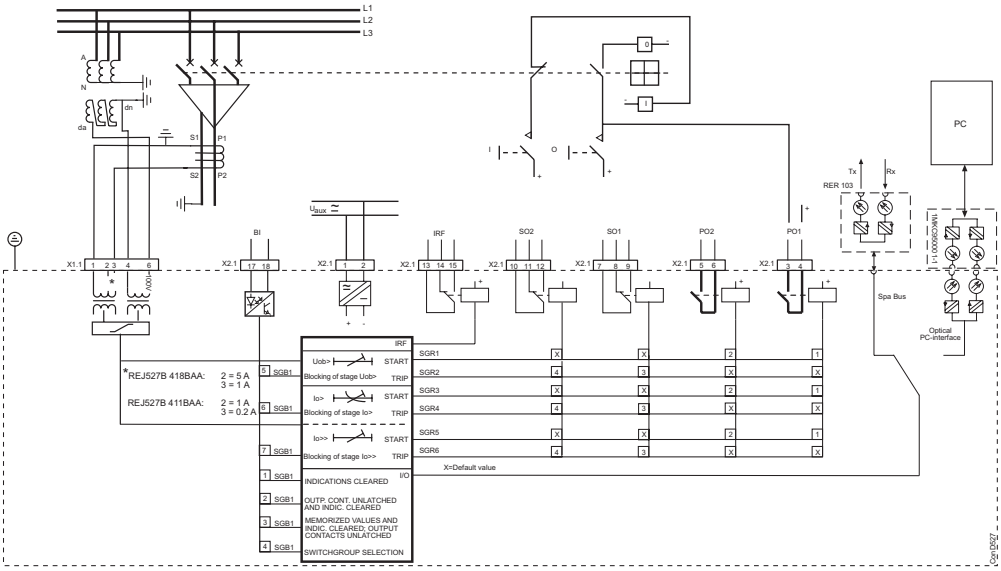

Fig. 1 Connection diagram of the directional earth-fault relay

Ordering

Order numbers

Order number (I_0 inputs 0.2 A/1 A)	REJ527B 411BAA (Article nr:1MRS091411-BAA)
Order number (I_0 inputs 1 A/5 A)	REJ527B 418BAA (Article nr:1MRS091418-BAA)

Accessories

Protective cover for rear connectors	1MRS060132
Flush mounting kit	1MRS050209
Semi-flush mounting kit	1MRS050253
Wall mounting kit	1MRS050240
Side-by-side mounting kit	1MRS050241
19” Rack mounting kit	1MRS050257
Optic bus connection module (RER 103)	1MRS090701
Opto-cable	1MKC950001-1

Configuration, setting and SA system tools

The following tool versions are needed to support the new functions and features of REJ 527 Release B:

- CAP 505 Relay Product Engineering Tools; CAP 505 v. 2.1.1, or later
- CAP 501 Relay Setting Tools; CAP 501 v. 2.1.1, or later
- LIB 510 Library for MicroSCADA; LIB 510 v. 4.0.3-1, or later
- SMS 510 Substation Monitoring System; SMS 510 v. 1.0.0-3, or later

References

Additional information

Technical Reference Manual	1MRS 750616-MUM
Installation Manual	1MRS 750526-MUM
Operator’s Manual	1MRS 751055-MUM

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